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NOTES ON THE OHIO VALLEY IN SOUTHERN INDIANA.

INTRODUCTION.

In recent years much work has been done on the streams and abandoned stream channels leading through or from glacial regions. The upper Mississippi, the Illinois, the lower Missouri, many smaller streams in Minnesota, Wisconsin, Illinois, and Iowa, the Wabash, and the upper Ohio have been examined more or less carefully, but on the lower Ohio, and more particularly that part between the falls at Louisville and the mouth of the Wabash, little or nothing has been done.¹

The present paper deals with a portion of this unexamined region in Spencer county, Indiana. Spencer county is in the southwestern part of Indiana. With reference to the Ohio, it is about 130 miles below the falls at Louisville and 95 miles above the mouth of the Wabash.² The region is particularly interesting, because it is near the middle of the base of the unglaciated triangle of Indiana.

The following paper will discuss (1) an old cut-off of the Ohio, (2) a series of river sands and gravels which seem to be Tertiary, (3) a probable extension of the Lafayette sea up the Ohio valley, (4) peculiarities of the loess on the bordering hills, including an apparent twofold character of the loess, and (5) a record of continental oscillation furnished by the deposits at this point.

The three physiographic regions.—Physiographically, Spencer county may be divided into two parts, a plain and a hill region. The plain may be subdivided into three parts. First, a broad,

¹JOUR. GEOL., Vol. III, "Preglacial Valleys of the Mississippi," by FRANK G. LEVERETT, pp. 745 and 759.

²For general location see Figs. 1 and 2. Enterprise is in the western part of the region described.

level plain extends southwest along the western boundary of the county. It has the same general trend as Little Pigeon Creek, and will therefore be called Pigeon Plain, although this valley is not now occupied by Little Pigeon Creek.¹

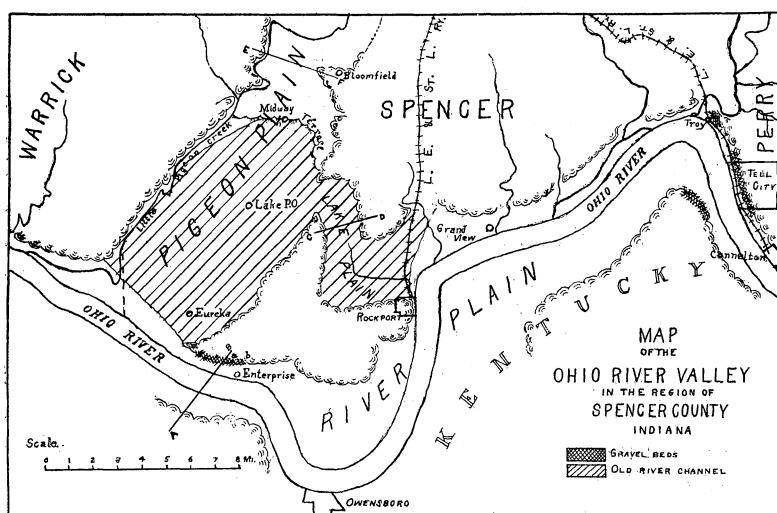


FIG. 1

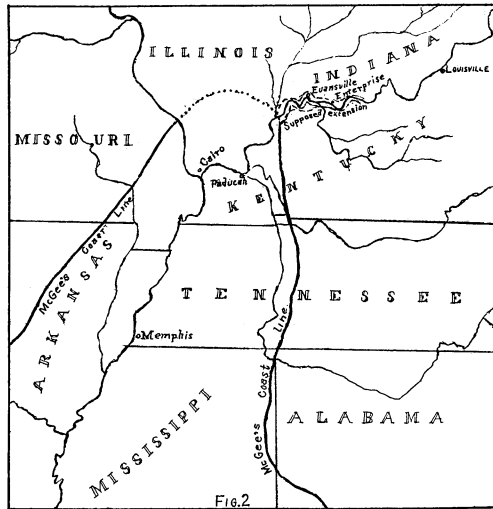
Pigeon Plain is naturally divided into two portions by a terrace about fifteen feet high, which begins near the point where Lake Plain joins it, and extends in a general northwesterly direction past Midway to Little Pigeon Creek (Fig. 1). The plain north of this line is about fifteen feet higher than the portion south. The soil north is a reddish clay in part of the region and a very black peaty soil in the other; while the soil south is entirely different, being the same as that which makes the river bottoms and the River Plain, into which it merges at its south end. Other differences between the northern and southern parts of Pigeon Plain will be mentioned later.

Where Pigeon Plain enters the northern part of the area under consideration it is about two miles wide. It gradually

¹The separation of Pigeon Plain and the valley of Little Pigeon Creek is not shown.

widens until at Midway it is about four miles and at Lake P. O. five, at which width it continues until it enters the second division of the plain region, the River Plain of the present Ohio.

The average width of the River Plain is between four and



MAP OF COAST LINE DURING THE LAFAYETTE
ACCORDING TO MCGEE, SHOWING ALSO SUPPOSED
EXTENSION UP THE OHIO VALLEY

five miles. That portion which lies in Indiana is very irregular on account of the meandering course of the river. It includes all land locally termed the river bottoms. Three and a half miles below Enterprise, River Plain merges into Pigeon Plain.

The third portion of the plain enters, or rather leaves, the River Plain between Grandview and Rockport (Fig. 1), its southern portion including part of the town of Rockport. It is here three miles wide, but soon narrows down to two miles. It extends westward three miles, where it turns abruptly northward, and there narrows to about one mile. After going three miles in this direction it turns westward again, and enters Pigeon Plain two miles east of Lake P. O. The narrow part of this plain was occupied by a shallow pond of water when this country

was first settled. This pond was called "The Lake" by the early settlers. For this reason this division may be termed Lake Plain, although the lake is a result and not a cause of the plain.

These three plains so merge into one another that it is impossible to tell where one begins and the other ends. The average level of the plain above low water in the Ohio at Rockport is about thirty-five feet. The difference in levels of all three is very slight, not being over twenty feet, except where trenched by modern channels. The surface is so nearly level that large portions of this county either are or were swampy.

The hill region occupies all land not occupied by the plains above outlined. It will be seen from the location and interconnection of these plains that the south part of the hill land is completely cut off from the north or main upland, and stands as a roughly triangular tract, with channels or low plains on every side.

This region is characterized by a great number of hills rising on an average from forty to sixty feet above the plain. The highest part of the triangular hill land is in Rockport, near the junction of Lake and River plains, where the hills rise 110 feet above the plain. The next highest is at the junction of Pigeon and River plains, where the hills reach the height of ninety feet; the bordering hills being in general higher than those in the interior and the hills on the south and east higher than those on the west.

The northern portion of the hill land is higher and more irregular. The highest point measured is about four miles north of Rockport, where one of the "Knobs" rises 240 feet above the general level of the plain, or 275 feet above the Ohio River at Rockport.

The loess.—The hills bordering the plains in the triangular hill land are all covered with loess. The southern border of the northern portion of the hill land is covered from Grandview as far as the point where Lake and Pigeon plains meet. From this point the loess follows the terrace mentioned above northward.

The region in the interior, in all the triangular hill land, and for a short distance north of the southern boundary of northern hill land is covered with typical interstream loess.

It follows in all of its details the characteristics of loess as given by Salisbury.¹ It is best developed along the hills bordering stream channels, where it has the peculiar yellow or yellowish buff loess color. Where exposed it weathers into perpendicular banks. As it recedes from the stream channels it becomes thinner and less characteristic. This change in thickness is accompanied by a change in color, so that in the interstream areas it so closely simulates residuary earth that it is impossible to tell where one begins and the other ends. In parts of the deposit, loess-kindchen are very numerous. They are of the same type as those described by Call in Arkansas,² which, according to his statement, differs from the typical northern loess-kindchen in being solid. Limonite tubes and concretions and immense numbers of very small land shells occur in some deposits.

The change from typical bluff loess to interstream loess is noticeable in passing northward from the terrace in Pigeon Plain. This peculiarity is of much assistance in working out the origin of the terrace.

The thickness of the loess along the border hills will average about 20 feet. The highest elevation of the loess above the plain is at Rockport, where it rises 110 feet. It was seen at places on the "Knobs" at heights of about 100 feet. In nearly all of the region it extends down to the level of the plains, and much of the plains is made of redeposited loess.

Along the eastern shores of Pigeon Plain this loess is interlaminated with a grayish sand in its lower portions. Along the edge of the hills, and parallel with them, are many lenticular sand hills ranging from 10 to 30 feet high.

¹ Ark. Geol. Survey, 1889, Vol. II, "On the Relationship of the Pleistocene to pre-Pleistocene formations of Cowley's Ridge," pp. 226-228.

² Ark. Geol. Survey, 1889, Vol. II, "Cowley's Ridge," by R. ELLSWORTH CALL, p. 38.

The obstructed valleys.—All the valleys which come from the hill region into the plain along the line of hills on the western side of the triangular upland have a very abnormal character. At the points where the streams pass from the upland to the plain, two long ridges of loess and sand 20 to 40 feet high jut out from each side like the arms of a great dam. These two parts almost meet, and the stream passes through the narrow V-shaped space between them. These dams are continuous with the loess-capping of the hills, which is so regular here that it looks much like a great artificial embankment. Although these dams are best developed along this line of hills, a similar tendency to dam the mouths of valleys on the east and south sides of the triangular hill land is shown.

These peculiar loess dams must be taken into consideration in any theory accounting for the manner of deposition of the loess of this region. The fact that valleys have been found facing in all directions, seems opposed to a wind origin. A prevailing southwest wind blowing over dried mud flats in the River and Pigeon plains could have formed all the dams on the western side of the triangular upland, but could not have formed some of the others. For this reason it seems probable that the loess of this region was deposited on the bordering hills as a natural levee by the swollen waters of the river, and that the dams across the mouths of these valleys represent continuations of this levee.

Driven-well area.—In all the plain region bounded by these loess-capped hills, that is, all the River Plain, Lake Plain, and that portion of Pigeon Plain south of the terrace, excepting a very narrow strip in a few places along the base of the hills, wells reveal a great trench filled with an irregular series of clays and water-bearing sands and gravels. This is the region of the driven wells. In the hill region and most of the region in Pigeon Plain north of the terrace all wells strike rock at comparatively shallow depths.

At Rockport wells have been driven 70 feet in the river alluvium without reaching rock. The normal depth of wells in

middle Lake Plain and northern Pigeon Plain south of the terrace ranges from 17 to 40 feet. Very few wells are deeper, and only those near the bordering hills reach rock. One well, 56 feet deep in the narrowest part of Lake Plain, did not reach rock. In River Plain wells range from 30 to 60 feet in depth.

From these wells can be learned something of the original depth of this filled valley. If all sands, clays, and gravels which underlie Lake, River, and a portion of Pigeon plains could be removed, a valley extending at least 56 and probably more than 70 feet below the present plain level, and having its sides of middle carboniferous strata, would be shown.

The old cut-off.—This valley under Lake Plain and the southern part of Pigeon Plain is the same depth as the half filled Ohio gorge of which it is a continuation. It is filled with the same materials. The hills on each side are capped with typical river-bluff loess in the same manner as those on the erosion scarp of the Ohio. The levels of the plain are so nearly the same that a portion of the waters in the flood of 1884 flowed swiftly through Lake Plain and entered Pigeon Plain, where one part followed the terrace and then turned southward and met the other part, which flowed south of Lake P. O., joining the waters of the Ohio again where Pigeon and River plains meet. This stream was four feet deep at the junction of Pigeon and Lake plains.

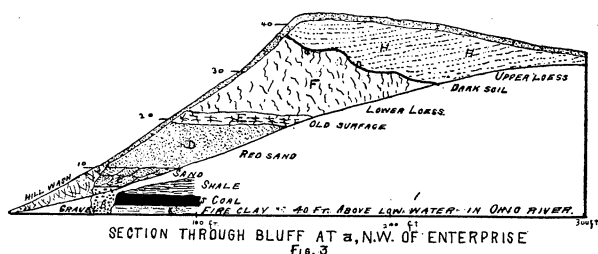
All these facts can lead to but one conclusion: The Ohio River at one time flowed through the Lake Plain and down through Pigeon Plain, entering the Ohio valley again between Enterprise and the eastern border of Warrick county.

To the erosive power of the river is to be attributed the greater part, if not the whole, of the gorge now occupied by that portion of the plain which has been called Lake Plain. In Pigeon Plain the work done was simply deepening and broadening on the eastern side of a broad valley extending from the northeast, which the river entered after cutting through the rock in Lake Plain. A portion of this more ancient valley, extending from the northeast, still remains intact north of the terrace, the terrace being simply the northern boundary of the Ohio's

downcutting in the older valley. The conspicuous differences in width which exist between various parts of the cut-off are to be explained by the fact that the river entered an old river channel when it came to Pigeon Plain. Nearly all the swampy areas mentioned above are simply parts of the old channel which have been but imperfectly filled.

An ancient valley from the north.—The ancient stream plain which the Ohio entered after cutting through the hills two miles east of Lake P. O., is locally called Pigeon valley; but, as has been stated, it is not at present occupied by Little Pigeon Creek. A cross section of the country from *E* to *F*, Fig. 1, shows Little Pigeon Creek in a young, V-shaped, rock-bound valley, separated by a hill of sandstone 30 feet high from the broad old alluvial-filled valley east of it (Fig. 12). Another section running east and west half a mile north of Midway shows the same peculiarities. Well sections in a few places west and northwest of Midway show a depression of 60 feet deep, filled with blue mud.

Tertiary gravel beds.—Near the base of the hills north of Enterprise (Fig. 1) is a series of sands and gravels. The roads cut through these bounding hills at different places and afford admirable sections of the formations. A section examined along the road running between sections 3 and 4, township 8, south range 7 west, showed the following strata (Fig. 3):¹



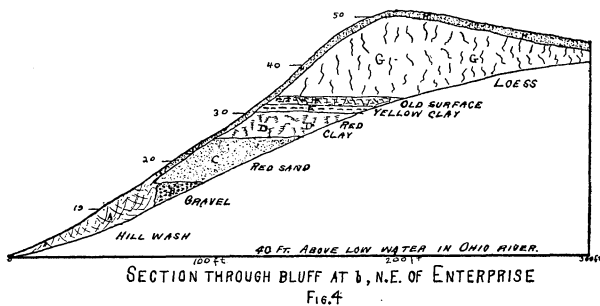
- | | Ft. | In. |
|---|-----|-----|
| A Hill wash—a reddish sandy clay, - - - - - | 5 | 0 |
| B Coarse gravel mixed with sand. The gravel is mostly a much glazed dark yellow chert, but also contains some | | |

¹The location of this section is shown at *i* in Fig. 2.

white quartz and fragments of geodes—largest pebbles from 3 to 4 inches in diameter. A layer of gravel about 3 inches thick stained black with manganese occurs near the base of the part exposed, - - - - - 1 6

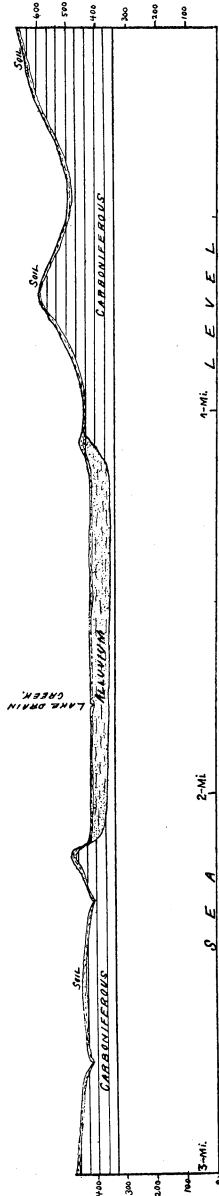
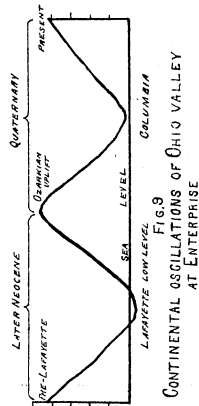
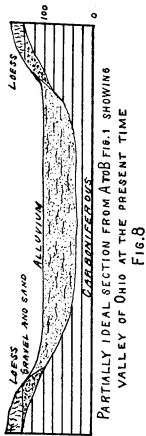
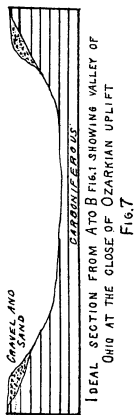
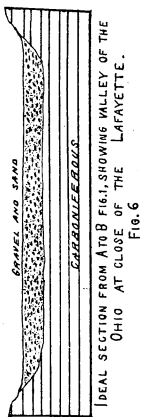
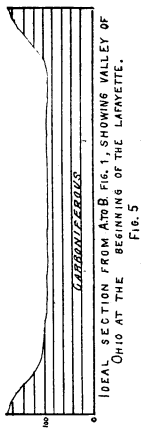
- C White, yellow and orange sands cross-bedded. In one place pure white sand is 9 inches thick. Three layers of white sand occur directly above the gravel. The line between the sand and the next stratum D is not well marked, the one grades into the other, - - - - - 3 6
- D Brick red sand, - - - - - 9 0
- E A much stained clay, indicating an old surface, - - - - - 2 0
- F A brown loam below turning into a typical loess above full of loess-kindchen - - - - - 10-15 0
- G A thin layer of dark soil discolored with iron, producing below plates of iron one-eighth of an inch, - - - - - 0 3
- H Loess grading into surface humus, - - - - - 5-10 0
- I Surface humus.

One mile east of the above the following strata were observed:



SECTION 2. (FIG. 4).

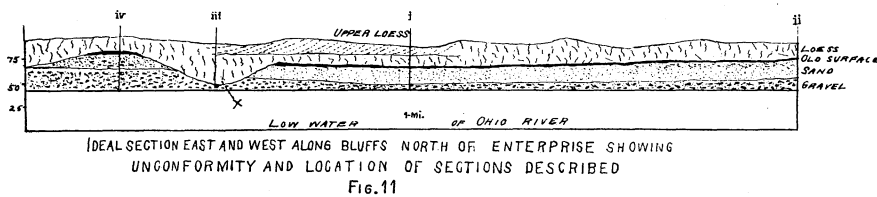
- | | Ft. |
|---|-----|
| A Hill wash—a reddish sandy clay, - - - - - | 10 |
| B Gravel—coarse, well-rounded yellow chert, with a few white quartz and geode pebbles somewhat stratified. Streaked with manganese, which in places forms a conglomerate, - - - | 5 |
| C Reddish sand turning above to reddish clay flecked with white, - - - | 10 |
| D Very red clay mottled with black, - - - - - | 5 |
| E Yellow to drab clay showing white streaks, - - - - - | 2 |



- F Mottled clay much weathered showing yellow, orange and black —
 evidently an old land surface, - - - - - 3
 G Loess containing a few concretions, - - - - - 15
 H Surface humus.

One-half mile of section 1 (See *iii*, Fig. 11.) only a thin layer of gravel is found. At this place it is directly overlaid with loess full of concretions. The sands and clays which overlie it in the other sections are absent; but scarcely a quarter of a mile west on the same hill gravels and sands rise 35 feet above the plain (See *iv*, Fig. 11.) and about 70 feet above the river. The gravel here does not appear to be in any particular bed, although it is more abundant near the base of the hill. At times it is found in lenticular beds between the sands. Brick red sands were seen at a height of 35 feet. The pebbles in many places are cemented together, forming large masses of conglomerates. Through the sands are plates of iron as much as 3 inches thick. The old surface was visible but not very well defined.

One mile west of section 1, at *v*, Fig. 11, the following strata were observed :



SECTION 5. (FIG. 11).

	Ft.
A Gravel — same as that found in other section. Somewhat bleached, -	20
B Sandy clay, red flecked with white, - - - - -	4
C Brown to drab loess, - - - - -	15
D Typical loess, - - - - -	15

The bipartite character of the loess is clearly shown in section 1, and is also shown, though less clearly, in section 5. The

widespread loess sheets of the southern Indiana and Illinois are considered by Leverett to belong to the Iowan age. This would seem to indicate that the lower loess is Illinoian and the upper Iowan.

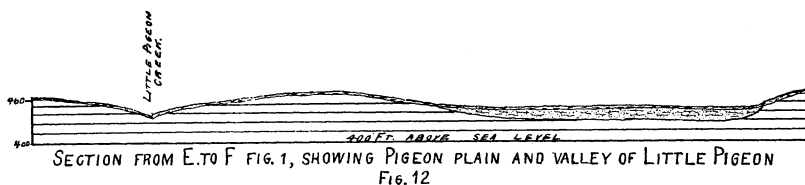
By reference to Fig. 1 it will be seen that the sections given above approach very close to the extreme southwest corner of the triangular hill land. Gravel was observed to rise 18 feet above the plain in a hill west of section 5. One-half mile west of this point the hills turn northwest in Pigeon Plain. The height of the gravels in the bluffs northeast of Enterprise would indicate that they could be easily found if they existed in this line of hills trending northeast.

A very careful search, in all available places, failed to discover these gravels anywhere along the old river cut-off, and it seems certain that they do not exist there. If this is the case no considerable breach existed in the line of hills from the southwest corner of the triangular upland to Warrick county, at the time of the deposition of the gravel, else it would have been filled with gravel, and at least some fragment of the deposit would be left. This would seem to show the age of the cut-off; it was cut after the deposition of the gravel.

These gravels and sands have been referred to the later Tertiary for several reasons:

First: The composition of the gravel is such that it cannot be referred to the glacial period; no pebbles of undoubted northern origin being found in the beds. It is obvious that, on account of its nearness to the southern limit of the glaciers, no beds of gravels could have been deposited at this place either during or following the ice-invasion without containing glacial pebbles. The main component of the gravel beds is yellow chert, probably derived from the Lower Carboniferous formations, through which the Ohio passes. The fragments of geodes are doubtless mostly from the St. Louis limestone and Upper Knobstone groups of Indiana. The quartz pebbles must have come either from parts of geodes or the Carboniferous conglomerates or both. As the first ice invasion, in this part of the

country, practically marks the beginning of the Pleistocene these gravel beds must be pre-Pleistocene. That the waters would have brought down glacial gravel, had these beds been deposited during any glacial or interglacial period, is shown by



the fact that in a recent terrace between Rockport and Grandview several deposits of glacial gravel are found.

Second: The gravel and sand is unconformably overlain by loess (*x* Fig. 11.) In several places an old weathered surface is found between the loess and gravel. It seems probable that the lower loess is Illinoian. This is additional evidence pointing to the conclusion that the gravels are preglacial, for as has just been shown they cannot belong to any glacial or interglacial period.

Third: There is a marked lithological resemblance of these deposits to the lower members of the deposits of gravel in the Jackson Purchase Region of Kentucky. The Kentucky gravels were called "stratified drift" by Loughridge in his report on the Jackson Purchase Region,¹ and were referred to the Quaternary. The lower parts of this stratified drift have since been referred to the Lafayette division of the Neocene by McGee,² after two conferences of scientists in one of which Loughridge took part. The gravels also agree lithologically with the Lafayette sands and gravels in other parts of Kentucky as described by McGee.

Fourth: The nonoccurrence of preglacial gravels in Pigeon Plain is without a reasonable doubt and their absence and the presence of typical river-bluff loess along the sides of the valley

¹ Kentucky Geol. Sur. 1888, Jackson Purchase Region, p. 57.

² U. S. Geol. Sur., 12th Ann. Rep., 1890-1, p. 500.

point strongly to the conclusion that the cut-off was made between the time of deposition of those deposits; there must, therefore, have been a considerable time interval between the deposition of the gravels and the loess during which this valley was formed.

Fifth: Farther up the river¹ gravels are found on both the Indiana and Kentucky sides. Well sections at Rockport show that river alluvium extends over 70 feet below the level of the river plain. These two facts show that after the partial filling of the valley with gravel the land rose and the river trenched through the gravel and deep into the underlying Carboniferous rocks (Fig. 7). This gorge cutting is correlated with the main gorge cutting of the central part of this country caused by the Ozarkian or Post Lafayette uplift. Hence the gravels are pre-Ozarkian and if instead of taking the first glacial invasion to mark the beginning of the Pleistocene the Ozarkian uplift is taken, the gravels and accompanying deposits are still pre-Pleistocene.

There are these five reasons for believing the gravels and sands to be pre-Pleistocene. Briefly they are:

1. Absence of glacial pebbles in the deposit.
2. Unconformity and old soil between the gravel and the loess.
3. Lithological resemblance of beds to known Tertiary beds.
4. Erosion record furnished by old river channel (?).
5. Pre-Ozarkian deposition of gravel.

Since they are pre-Pleistocene they are here referred to the Lafayette division of the Neocene because, so far as the writer is aware, they resemble no other pre-Pleistocene deposits.

Fig. 2 gives the location of the Lafayette coast line according to McGee.² From the Wabash River northward McGee represents the ocean waters as extending in an indefinite way over southern Illinois. Mr. McGee in speaking of this map says

¹ It is regretted that lack of time prevented the examination of the hills below Owensboro, Ky. For several reasons it is believed that a corresponding series of gravel will be found there.

² 12th Ann. Rep. U. S. Geol. Sur. 1890, pp. 353-521.

that the data from which it was made was incomplete in the Mississippi embayment and so the coast line is very general.

If these deposits are Lafayette it would seem that an arm of the sea extended up the Ohio valley from the great Mississippi embayment past Posey, Vanderburg, Warrick, Spencer and into, if not past, Perry county, Indiana. In order to fully establish the size and shape of this embayment it would be necessary to examine carefully all lands bordering the Ohio River on both sides from Perry county, Indiana, to the mouth of the Wabash. Figure 2 shows in a general way this supposed extension of the embayment.

The data collected throws some light on the history of the Ohio valley at this point. This history is shown in Figs. 5, 6, 7, and 8. In these no attempt has been made to show the exact character of the rock bottom of the channel as the well sections furnish no evidence on this point. It may be mentioned, as having some bearing on the history, that a rock shelf comes out from the base of the hills north of Enterprise and extends about 20 feet underground to the present river channel. Just across the river wells are reported 60 feet deep and showing that here as at Rockport there is a deep filled valley.

During the pre-Lafayette period the land stood at about its present level, and the Ohio River cut out the valley shown in Fig. 5. This period was followed by the Lafayette submergence when the sands and gravels were laid down as an estuarine deposit and the valley probably assumed about the appearance shown in Fig. 6.

During the post-Lafayette or Ozarkian period the land stood more than 70 feet higher than now and the river after cutting through the Lafayette sands and gravels cut deep into the underlying Carboniferous rocks (Fig. 7); cutting from side to side it took away the Lafayette gravels in places along the side of the river leaving deposits only here and there. Then followed another subsidence and the river filled up its channel making a broad alluvial flood plain. At some time after the post-Lafayette high level the loess was deposited on the bluffs on either side

making them 15 to 30 feet higher. This gives the valley of the present (Fig. 9).

Figure 9 is a diagrammatic representation of these earth oscillations of the Ohio valley during the Lafayette part of the Neocene and the Pleistocene, the Columbia submergence being based on the supposed aqueous origin of the loess of this region. Only the vertical movement is here represented as no data bearing upon the time covered in each movement was collected.

It should be noticed that this record of continental oscillation agrees very closely with the record of the Mississippi embayment, as given by McGee.¹

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¹U. S. Geol. Sur., 12th Ann. Rep., 1890, p. 429.